DOCUMENT RESUME

ED 138 889 CG 011 361

AUTHOR Mayer, Richard E.
TITLE Interactive Effects of Trait-Anxiety and Self-Pacing in Problem Solving.
PUB DATE [74]
NOTE 17p.; Paper presented at the Annual Meeting of the Western Psychological Association (Los Angeles, California, April 8-11, 1976); Best Copy Available.

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS Achievement; *Anxiety; Cognitive Processes; Motivation; Pacing; Performance Tests; *Problem Solving; Psychological Patterns; Research Projects; Rote Learning; Task Performance; Timed Tests; *Time Factors (Learning)

ABSTRACT

Ninety-two subjects solved a series of problems without enough time to finish and worked at a pace and in an order determined by the experimenter (Experimenter- Paced) or at their own pace and order under self-administered time deadlines (Self-Paced). Self-pacing resulted in superior performance on rote and poorer performance on cognitive problems relative to Experimenter-Paced groups. Self- pacing had no effect on low anxious subjects but increased performance for high anxious subjects, and high anxious subjects performed better on rote and poorer on cognitive problems relative to low anxious subjects. Practical and theoretical implication were discussed. (Author)

****
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
****

ED138889

Interactive Effects of Trait-Anxiety and Self-Pacing in Problem Solving

Richard E. Mayer

University of California, Santa Barbara

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

BEST COPY AVAILABLE

CG 011 361

In solving a set of problems without enough time to finish (i.e. task overload) performance may be influenced by whether subjects work on each problem in an order and for a time period completely controlled by the experimenter (E-paced) or at their own pace and order with self-administered time deadlines (S-paced). Three important questions, suggested by careful reviews of the related literature (Levitt, 1967; Atkinson & Raynor, 1974) are: (a) Does self-pacing produce different effects for different types of problem tasks--what is performed best under self pacing? This question is informed by the interaction between pacing and task, such as the classic finding that stress has a negative effect on complex or difficult responses relative easier or simplier responses (Patrick, 1934; Erikson & Wechsler, 1955). (b) Does self-pacing have different effects for subjects with different levels of trait anxiety--who performs best under self-pacing? This question is informed by the interaction between pacing and anxiety, such as the typical finding that high anxious subjects tend to work more poorly under time pressure relative to low anxious subjects (Morris & Liebert, 1969; Siegman, 1956). (c) Does the subject's level of trait anxiety have different effects for different problem tasks--who performs what best? This question is informed by the interaction between anxiety and task, such as the typical finding that anxiety has a negative effect on complex or difficult tasks relative to

simplier or easier ones (Harleston, 1962; Korchin & Levine, 1957; Montague, 1953). The present study attempted to increase the generalizability of existing findings with respect to these interactions by examining more complicated problem tasks than the traditionally used tasks of discrimination performance, list learning and anagrams; by using a motivational manipulation (i.e. self-pacing) that more closely approximates the circumstances of the overburdened worker; and by using a more recent measure of anxiety rather that the traditionally used Manifest Anxiety Scale (Taylor, 1953) and Test Anxiety Questionnaire (Mandler & Sarason, 1952).

EXPERIMENT I

Experiment I examined the first question.

Subjects and design. Twenty subjects were recruited from the Human Performance Center Subject Pool and were paid $2.00 for the one hour session. Half the subjects received the Self-Paced treatment and half did not (Experimenter-Paced), but all subjects attempted to solve the same series of problems consisting of Cognitive and Rote problems.

Materials. Eight problem tasks, seven of which were adapted from French's (1963) Kit for Cognitive Reference, were typed on separate sheets of paper. Four tasks were considered to be clerical or "rote": (a) target search for all the letter "a's" in a 600 word passage, (b) identity judgments for 100 pairs of numbers, (c) 100 multiplication and subtraction problems with two-digit numbers, (d) 60 division and addition problems with two and three-digit numbers. Four tasks were considered to be general reasoning or "cognitive": (a) 64 figural concept formation

items, (b) 15 oddity problems, (c) 32 two-term deductions (from Baddeley, 1968), and (d) 15 three-term deductions. In addition, a wooden rack with eight slots, a large electric timer and a stop watch were used.

Procedure. Subjects were randomly assigned to treatment groups (either Self or Experimenter-Paced) and run individually. For the self-paced condition, each subject was introduced to all eight tasks, told he would have a total of 25 minutes to work on them as indicated by the timing clock, told he could proceed in any order and return to unfinished tasks, and was allowed to work a maximum of three minutes on each problem. For the Experimenter-Paced group, the problems were presented in an order determined by the experimenter (randomized by a latin square); after three minutes of work on the first problem that problem was over and the next problem was worked on for three minutes and so on.

Results. Proportion correct response by type of task for the two treatment groups, shown in Table 1, was obtained by averaging the number correct divided by total possible for each of the four tasks of each type. Although an analysis of variance revealed no overall effect due to pacing ($F(1, 32)$ 1.00, p = n.s.), there was significant two-way interaction between pacing and problem type ($F(1, 22) = 5.67$, $p < .05$) with Self-Paced subjects performing better on Rote and worse on Cognitive tasks relative to Experimenter-Paced subjects.

EXPERIMENT II

Experiment II examined the second question.

Subjects and design. Twenty-four paid subjects were recruited from

a pool of University of Michigan students who had previously taken the State-Trait Anxiety Inventory or STAI (Spielberger and Forsuch, 1966). A 2x2 between subjects design was used with the factors being anxiety (High vs. Low score on the STAI) and pacing (Self vs. Experimenter-Pacing).

Materials. Eight problem tasks, adapted from traditional one-answer problem-solving puzzles, were typed on separate sheets of paper. The tasks were to generate a 4x4 latin square, to arrange a 3x3 magic square (from Schuh, 1968), to solve a complex anagram (from Tresselt and Mayzner, 1966), to connect nine dots with four consecutive lines (from Schuh, 1968), a Katona (1940) card trick, a Katona (1940) matchstick problem, a variation of the Luchins (1942) water jar problem, and a geometric puzzle (from Schuh, 1968). In addition to the other materials used in Experiment I, there were eight loud ticking chess clocks arranged on tiers for each of the eight problems.

Procedure. Subjects who scored below 15 (out of 66) or above 25 on the Trait Anxiety scale of the STAI were randomly assigned to treatments, and run individually. The same procedure was used as in Experiment I except that all subjects were instructed they would receive a bonus for good performance, and a ten minute limit was imposed on each task; for self-paced subjects, there was a 50-minute overall limit indicated on the large timing clock and there were individual 10-minute limit clocks for each problem for subjects to start whenever working on the problem and stop whenever changing to another.

Results. Proportion correct solutions and average solution time for the eight items (unsolved items were assigned a solution time of 600 seconds) are shown in Table 2 for the four groups. An analysis of variance revealed that Self-Paced subjects solved significantly more problems than the Experimenter-Paced group ($F(1, 20) = 14.35$, $p < .005$) and High Anxious subjects solved significantly more problems than the Low Anxious group ($D(1, 20) = 5.29$, $p \leq .05$). A significant anxiety x pacing interaction ($F(1, 20) = 7.35$, $p < .025$) is reflected in the observation that self-pacing had no effect on Low Anxious subjects but greatly improved performance for High Anxious subjects. The results with respect to solution times closely shadow these findings; however, only the main effect of stress reached a statistically reliable level ($F(1. 20) = 5.72$, $p < .05$).

An analysis of the distribution of solutions over the solution period shows that the Self-Paced/High Anxious subjects performed relatively well during the latter hald of the period, on problems rated most difficult by the other groups. For example, proportion correct at the half-way point were: S-Paced/High Anxiety, .56; S-Paced/Low Anxiety, .56; E-Paced/High Anxiety, .38; E-Paced/Low Anxiety, .38.

Supplemental Study. In order to replicate the surprising finding that high anxiety was an asset in stressful problem solving situations, four new subjects scoring low in anxiety were matched for Mathematics SAT score with four new subjects scoring high in anxiety, and were given the self-pacing treatment described in Experiment II. As in Experiment II, High Anxious/Self Paced subjects averaged 85% correct solutions and 311 seconds per solution while Low Anxious/Self-Paced subjects averaged

56% correct and 396 seconds per solution ($t = 3.86$, $df = 6$, $p < .01$, for proportion correct; $t = 1.44$, $df = 6$, p = n.s., for solution time).

EXPERIMENT III

Experiment III examined the third question and attempted to replicate and extend the findings of a pacing x task interaction in Experiment I and pacing x anxiety interaction in Experiment II.

Subjects and design. Forty paid subjects who had previously taken the STAI were recruited from the Human Performance Center Subject Pool. A 2 x 2 factorial design was used for between subjects factors, namely pacing (Self vs. Experimenter-Pacing) and anxiety (High vs Low Anxiety); since all subjects received the same problems, type of problem (Rote vs Cognitive) served as a within subjects factor.

Materials. Eight problems -- each having a single criterion for completion as in Experiment II rather than a series of short items as in Experiment I -- were typed on separate sheets of paper. Four of the problems were adapted from the Rote problems of Experiment I: (a) target search for 80 letter "a's", (b) identity judgments for 40 mismatched number pairs, (c) chain of multiplications and subtractions totaling one number, (d) chain of divisions and additions totaling one number. The four Cognitive problems were the same as those used in Experiment II: (a) anagram, (b) water jar, (c) card trick, (d) matchstick. The same clocks and holders were used as in Experiment II, and a pre-experimental questionnaire was constructed.

Procedure. Subjects were randomly assigned, except for the constraint of matching groups for average SAT-M score, and run individually. The Self and Experimenter-Paced conditions were the same as in Experiment II,

including the 10 minute per problem time limits.

Results. Data for solution times and proportion correct response were recorded and analyzed as in Experiment II, and are shown in Table 3. An analysis of the results with respect to solution times revealed: (a) a superiority of Self-Paced subjects over Experimenter-Paced subjects ($F(1, 32) = 3.00$, $p < .10$) and Low Anxiety subjects over High Anxiety subjects ($F(1, 32) = 15.78$, $p < .001$), (b) the same pattern of pacing x task interaction as in Experiment I with the Self-Paced group performing better on Rote and slightly worse on Cognitive problems relative to Experimenter-Paced subjects ($F(1, 32) = 5.64$, $p < .025$), (c) the same pattern of pacing x anxiety interaction as in Experiment II with self-pacing having no effect on the average solution time of Low Anxious subjects but having a positive effect for High Anxious subjects ($F(1, 32) = 2.96$, $p < .10$), (d) a pattern of anxiety x task interaction in which High and Low Anxious subjects performed at about the same rate for Rote problems but the High Anxious group performed much worse relative to the Low Anxious group on Cognitive problems ($F(1, 32) = 14.13$, $p < .001$).

The results with respect to proportion correct response show the same general patterns as above; however, only the anxiety x task type interaction reached statistically reliable levels ($f(1, 32) = 15.78$, $p < .001$). There was no evidence, in any case, of a three-way interaction among pacing, anxiety and task type ($F < 1.00$ for time and Proportion correct.

As in Experiment II, an analysis of the distribution of solutions over the total solution period shows that relative to Experimenter-Paced/ High Anxious groups the Self-Paced/High Anxious subjects performed particularly well during the latter half of the solution period, especially on more difficult "cognitive" problems. For example, proportion correct at the half-way point were: S-Paced/High Anxiety, .40; S-Paced/ Low Anxiety, .38; E-Paced/ High Anxiety, .31; E-Paced/Low Anxiety, .31.

Discussion

The pacing x task interaction (Experiments 1 & 3) and the anxiety x task interaction (Experiment 3) help extend traditional findings to a new area; in addition, these findings are only partially consistent both with Spence's (1960) "drive level" view that stress energizes well-learned responses more than complex responses, and with Sarason's(Sarason, Davidson & Lighthall, 1960) "situational reaction" view that subjects learn situational reactions to stress which may interfer more with complex performance than well-learned performance. The most surprising finding, represented by the pacing x anxiety interaction (Experiment 2, 3), is most consistent with Sarason's "situational reaction" concept; apparently high anxious subjects may begin by reacting to self-pacing in task-irrelevant ways but eventually react by maintaining momentum as the session continues.

References

Atkinson, J. and Raynor, J. Motivation and Achievement. Washington: Winston, 1974.

Baddeley, A. D. A 3 min reasoning test based on grammatical transformation. Psychonomic Science, 1968, 10, 341-342.

Eriksen, C. W. andWechsler, H. Some effects of experimentally induced anxiety upon discrimination behavior. Journal of Abnormal and Social Psychology, 1955, 51, 458-463.

French, J. W. Kit of Reference Tests for Cognitive Factors. Princeton, N. J.: Educational Testing Service, 1963.

Harleston, B. W. Test Anxiety and performance in problem solving situations. Journal of Personality, 1962, 30, 557-573.

Katona, G. Organizing and Memorizing. New York: Columbia University Press, 1940.

Korchin, S. J. and Levine, S. Anxiety and verbal learning. Journal of Abnormal And Social Psychology, 1957, 54, 234-240.

Levitt, E. E. The Psychology of Anxiety. Indianapolis: Bobbs-Merrill, 1967.

Luchins, A. S. Mechanization in problem solving: The effect of einstellung. Psychological Monographs, 1942, 54, Whole No. 248.

Mandler, G. and Sarason, S. B. A study of anxiety and learning. Journal of Abnormal and Social Psychology, 1952, 47, 166-173.

Montague, E. K. The role of anxiety in serial rote learning. Journal of Experimental Psychology, 1953, 23, 91-95.

Morris, L. and Liebert, R. Effects of anxiety on timed and untimed intelligence tests. Journal of Consulting and Clinical Psychology, 1969, 33, 240-244.

Patrick, J. R. Studies in rational behavior and emotional excitement II: The effect of emotional excitement on rational behavior in human subjects. Journal of Comparative Psychology, 1934, 18, 153-195.

Sarason, S. B., Davidson, K. S., Lighthall, F. F., Waite, R. R., and Ruebush, B. K. Anxiety and Elementary School Children, New York: Wiley, 1960.

Schuh, F. The Master Book of Mathematical Recreations. New York: Dover, 1968.

Siegman, A. W. The effect of manifest anxiety on a concept formation task, a nondirected learning task, and on timed and untimed intelligence tests. Journal of Consulting Psychology, 1956, 20, 176-178.

Spence, K. W. Behavior Theory and Learning, Englewood Cliffs, N. J.: Prentice-Hall, 1960.

Spielberger, C. D. and Gorsuch, R. L. Mediating processes in verbal conditioning. Vanderbilt University Technical Report, 1966.

Taylor, J. A. A personality scale of manifest anxiety. Journal of Abnormal And Social Psychology, 1953, 48, 285-290.

Tresselt, M. E. and Mayzner, M. S. Normative solution times for a sample of 134 solution words and 378 associated anagrams. Psychonomic Monograph Supplement No. 15, 1966, 1, 293-298.

Table 1

Proportion Correct Response for Two Pacing Groups by Type of Problems-Experiment I

Pacing Treatment	Type of Task	
	Rote	Cognitive
Self-Paced (Overload)	.56	.59
Experimenter-Paced	.49	.66

Table 2

Proportion Correct Response and Average Time Per Solution for Two Pacing Groups by Anxiety Level-Experiment II

Pacing Treatment	Proportion Correct		Average Time (Sec)	
	Level of Anxiety		Level of Anxiety	
	Low	High	Low	High
Self-Paced (Overload)	.69	.94	334	277
Experimenter-Paced	.67	.65	363	382

Table 3

Proportion Correct Response and Average Time Per Solution for Four Paicng x Anxiety Groups by Type of Task-Experiment III

Pacing x Anxiety Group	Proportion Correct		Ave. Time (Sec)	
	Type of Task		Type of Task	
	Rote	Cognitive	Rote	Cognitive
Self-Paced/High Anx (Overload)	.95	.52	388	438
Self-Paced/Low Anx (Overload)	.91	.75	419	354
Experimenter-Paced/ High Anx	.80	.40	486	465
Experimenter-Paced/ Low Anx	.77	.82	455	316

Footnotes

1. This research was conducted at the Human Performance Center, University of Michigan, and was supported by the Office of the Advanced Research Projects Agency, under Order No. 1949, and monitored by the Air Force Office of Scientific Research under Contract No. F44620-72-C-0019. I appreciate the assistance of Robert Bjork, Richard Pew, and Daniel Weintraub. The comments of John Atkinson on an earlier draft are also appreciated.

2. Requests for reprints should be sent to: Richard Mayer, Department of Psychology, University of California, Santa Barbara, California 93106.